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Final Report to the

NAVAL RESEARCH LABORATORIES

on

DEVELOPMENT OF CONSTITUTIVE BEHAVIOR OF

MATERIALS FOR SDRW'S

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INTRODUCTION

This investigation was part of a failure analysis project concerned with repeated malfunctioning of sonar windows installed on vessels and submersibles. The problem encountered was the gradual failure of large wire reinforced rubber domes containing sonar equipment. The particular failure mode encountered was the corrosion of the wire reinforcement in such domes in the vicinity of seams on the forward centerline of these large structures.

It appeared from the initial investigations as well as subsequent and detailed examinations that the construction of the seam with its multiple overlays led to local stress concentrations which could, under sufficiently high and prolonged sea states, induce failure in the rubber component of the structure with subsequent access by the sea water to the steel wire structure.

Two aspects of assistance were involved under this contract: One addressed the assistance in the engineering and failure analysis of the typical structure, with repeated reviews of the progress and alternate design options; the other aspect concerned the development of constitutive description of the steel/rubber composite material used in the dome construction.

SUMMARY

In order to be able to analyze the stresses developed under sea operations it was necessary to provide numerical analysis capability, which was no mean task in view of the fact that this type of structure is unusually large while made of a relatively highly flexible material. As part of the contract for dome production certain methods and analyses were proposed and executed for obtaining the requisite properties of the dome material. Upon cursory examination it was determined that the results of that analysis were incorrect and not useful for a reliable engineering analysis.

As a consequence of this deficiency it became necessary to develop new means of characterizing the dome shell material. This task was tackled under the present contract and completed successfully:

The task required the construction of new equipment as well as the use of existing standard test facilities for developing an anisotropic characterization of the steel/rubber multilayered composite material. The characterization needed to be performed in both in-plane deformations as well as in the bending mode stiffness and involved nonlinear/viscoelastic response of the material components.

This work was summarized in several reports, all of which are condensed into the reports attached to this final report. As a result of these investigations it is now possible to analyze the type of structures represented by the sonar dome windows numerically, provided sufficient care is exercised in discretizing the structure in a sufficiently refined manner. We believe that this effort was carried out elsewhere under Navy guidance, but that aspect was not under the control of the presently discussed program.

We consider the attached reports part of this final report; repeated reporting appears unnecessary at this time.

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